POLICY BRIEF

Solar-Powered Cooking in Kenya

A pilot of secondary use of solar irrigation systems

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Summary

Surplus energy from solar irrigation systems can be harnessed to expand access to clean energy, promote gender equality and social inclusion, and maximize public investments. We conducted a randomized controlled trial in Kenya to test whether solar irrigation systems with batteries could power electric pressure cookers (EPCs). The study assessed EPC adoption and changes in cooking practices, energy consumption, and gendered time use.

Secondary use of solar irrigation power for cooking was found to be feasible. The majority (63%) of treated households reported using the cooker at least once a week, and most (56%) were satisfied with it. Education, rather than gender or income, was the strongest predictor of adoption, suggesting information and familiarity may be important factors. Among those who used the devices regularly, EPCs modestly reduced reliance on traditional fuels (by 10–12 percentage points). However, these results were not statistically significant. EPCs also raised solar battery electricity consumption by up to 26% among active users.

The use of EPCs was constrained by lower battery capacity and a tendency for households to prioritize lighting or entertainment over cooking. Women make most cooking decisions but rarely control battery use, which may have limited the integration of EPCs into daily routines. Affordability also remains a key hurdle. In this study, the EPCs were provided free of charge, but when asked, most households said they were only willing to pay one third of the current market price.

To realize the potential of solar irrigation systems, policies can promote (i) inclusive access to productive secondary energy uses, (ii) adequate battery storage, (iii) gender-equitable control over household energy assets, (iv) targeted financing or subsidies for EPCs, and (v) training and behavioural support to boost sustained adoption.[1]

[1] This brief is a condensed version of *Beyond Irrigation: Turning sunlight into supper for Kenya's women and farmers*: https://www.iisd.org/publications/report/beyond-irrigation-solar-power-kenya.

Introduction

Solar irrigation systems represent a significant but underused source of renewable energy in many regions facing energy poverty (Wazed et al., 2018). Such systems provide critical water access for agriculture but often remain idle for much of the day or year, resulting in wasted generation potential (Rahman & Jain, 2021b). Leveraging the secondary use of solar power—such as for lighting, charging, or cooking—offers an opportunity to maximize the value of solar irrigation investments, expand access to clean energy, and enhance social equity.

Currently, subsidies for solar irrigation primarily benefit landowning male farmers, leaving women and marginalized groups with limited direct access to the technology (Rahman & Jain, 2021a). Policies that facilitate broader community use of surplus solar power could both strengthen inclusion and improve the cost-effectiveness of energy subsidies (Onsongo et al., 2023).

In Kenya, there are an estimated 35,500 solar water pumps in operation (EED & VeraSol, 2021). The Kenyan government has funded a community-level solar-powered water pump in several counties across the country (Njagi, 2019). The widespread use of solar irrigation pumps (SIPs) suggests there is a major opportunity to reduce energy poverty in these households through secondary use.

To explore this potential, the International Institute for Sustainable Development and SunCulture conducted a randomized controlled trial (RCT) to evaluate whether solar irrigation systems could support secondary applications—in this case, powering electric pressure cookers (EPCs). A subset of SunCulture's customers received EPCs powered through the batteries included with their solar irrigation systems.

The RCT examined the uptake and use of EPCs among SunCulture clients and assessed their impacts on cooking behaviour, energy use, and time allocation. The study also explored the socio-economic profile of participants and potential barriers to the effective use of EPCs as part of solar irrigation systems' secondary use. Specifically, it aimed to

1. assess whether SIPs could support productive and household secondary uses;
2. identify approaches to enhance benefits for the vulnerable, particularly women;
3. reduce reliance on traditional fuels and the associated health and environmental burden; and
4. increase the overall value and sustainability of SIPs for providers and users.

The team conducted a baseline survey in October 2024, followed by the distribution of EPCs among households in the treatment group in early 2025. An endline survey was fielded in June 2025. All respondents participated in both surveys.

Key Results

Household Profile and Energy Access

Most respondents used their pumps frequently. Over half operated pumps daily, leaving limited spare energy and battery capacity for secondary uses such as cooking. Around 17% of users operated their pumps only weekly or seasonally, leaving more surplus power.

Cooking practices reflected a mix of traditional and modern energy use. At baseline, 76% of households used firewood and 70% used charcoal, but 52% also used liquefied petroleum gas (LPG). The sample thus represents a transitional population—one straddling biomass reliance and partial access to modern fuels. Balance tests confirmed that the randomization of treatment and control groups was successful: none of the baseline characteristics predicted treatment assignment.

Almost all survey respondents had completed secondary school, and two thirds had some level of tertiary qualification. Monthly household expenditures were between KES 10,000 and KES 20,000 (USD 77–USD 155), consistent with upper-middle rural income levels. These households could afford the irrigation and battery systems at market prices.

Uptake and Use of EPCs

Among treated households, ownership of an EPC rose from 7% to 87%, compared with 12% in the control group. Weekly use increased correspondingly: 63% of all treated households reported using the cooker at least once a week. Statistical estimates show the treatment raised EPC ownership by 76 percentage points and use by 49 percentage points—substantial impacts relative to similar clean cooking trials.

Better-educated respondents were more likely to integrate devices into their cooking routines. In contrast, gender, income, and age did not significantly affect usage. This suggests that information and familiarity, rather than affordability or gender alone, may be central to adoption.

Overall satisfaction with EPCs was positive, though lower than for LPG. A majority of respondents (56%) were somewhat or very satisfied, compared with higher satisfaction levels for LPG. This finding may reflect the convenience and speed of LPG, and the relative novelty and power constraints of EPCs within solar battery systems.

Effects on Fuel Use and Energy Consumption

The intervention modestly reduced reliance on solid and "dirty" fuels. When restricting the sample to households that used EPCs (LATE estimates), the declines were about 10 percentage points for firewood and 12 for any dirty fuel, suggesting directionally positive but statistically insignificant effects, likely owing to limited sample size and heterogeneous treatment responses.

Data from SunCulture's systems showed that battery electricity consumption rose by 12%–18% among all treated households and by 20%–26% among those who used their cookers.

These results, though statistically insignificant, are consistent with increased appliance use and a tentative strengthening of secondary solar power utilization.

Taken together, these findings suggest that EPCs have the potential to complement solar irrigation systems by expanding electricity demand and partially displacing traditional cooking fuels. However, the magnitude of these effects remains uncertain, both because of small sample sizes and because battery capacity constraints may limit practical usage.

Time Allocation and Gendered Impacts

Overall, there was no clear or statistically robust reduction in time spent gathering firewood or charcoal. Among households using EPCs, there were signs of a decline in women's time devoted to fuel collection, partly offset by a small increase in men's reported collection time. This mixed pattern likely reflects the widespread presence of LPG in the sample, which had already reduced the time burden of fuel collection prior to the trial.

Understanding the Limits to Impact

Several factors help explain the modest and noisy quantitative effects. First, **power competition** within the household battery system was a recurring issue. The SunCulture battery supports multiple uses—lighting, TV, and phone charging—and households indicated a preference for using any additional stored power for entertainment or communication rather than cooking. Since EPCs are energy-intensive, their operation can crowd out other valued uses.

Second, **intra-household decision-making dynamics** may constrain adoption. Survey and interview data show that, while women are primary decision-makers for food preparation in 80% of households, only 20% control how the battery is used. This mismatch between who cooks and who allocates energy resources could create friction that limits EPC utilization, echoing broader findings in gender energy research. However, our study did not test the gendered preference of energy use within households.

Finally, **price sensitivity** is a likely barrier to scale up. Willingness-to-pay data show that 79% of respondents were willing to purchase an EPC at KES 3,000 (USD 23), but only 21% would do so at KES 9,000 (USD 69). The estimated price elasticity of demand (1.17) indicates that uptake would respond strongly to cost reductions, reinforcing the case for targeted subsidies or financing models to make EPCs affordable at scale.

Policy Recommendations

The following policy recommendations emerge from the study in Kenya:

Secondary use is feasible and can benefit women and smallholders, but the design needs to consider consumer circumstances and preferences:

- Ensure subsidies and programs account for surplus solar power and build in mechanisms to channel it toward socially beneficial end uses like cooking or lighting.

- Integrate structured consumer feedback, prioritizing women's voices, so system and appliance design reflect cooking habits and household decision making.

Mechanisms to steer secondary use toward intended outcomes:

- Where subsidies are provided to support clean cooking, put energy allocation settings or "priority ports" in place; these system controllers reserve or prioritize a portion of battery/solar photovoltaic power for specific uses (e.g., cooking, refrigeration, etc.) to ensure subsidized technologies are used as intended.
- Monitor the end uses that batteries serve and incentivize intended use through monetary benefits (reduced monthly instalments, discounts on service fees) to households that demonstrate consistent use of solar e-cooking or other priority end uses.

Incentivize the utilization of secondary-use devices:

- Align price interventions with households' willingness to pay by using rebates, results-based financing, or pay-as-you-go models.
- Redirect a portion of LPG subsidies toward supporting e-cooking adoption.
- Work with solar providers, manufacturers, think-tanks, and consumers to inform incentive design and optimal pricing strategy.

Develop research and development (R&D) and pilots for efficient secondary-use devices:

- Develop R&D incentives for energy-efficient solar-compatible cooking devices for manufacturers in manufacturing hubs. Incentives for the uptake of such technologies in other jurisdictions will also create economies of scale.
- Pilot variations (battery-heavy vs. battery-light systems) in multiple geographies to identify optimal configurations most suited to consumer behaviour.

Establish a learning agenda:

- Scale up structured pilots in diverse contexts (peri-urban vs. remote, LPG-available vs. LPG-scarce, with/without batteries) to identify the strongest use cases.
- Track fuel displacement, gender(ed) impacts, and secondary-use efficiency.
- Map the use cases for secondary use to understand the different technology options and under which circumstances each might be most feasible and beneficial.

Conclusions

The RCT demonstrates that, when offered for free, EPCs are enthusiastically accepted and actively used. Usage patterns suggest genuine interest in clean cooking with electricity, especially among educated households. Tentative reductions in solid fuel use and increased solar electricity consumption hint at positive synergies between clean cooking and solar irrigation systems. However, battery constraints, competing energy demands, and possible intra-household power dynamics limited the realized impact.

For businesses and policy-makers, these results underscore that the availability of technically compatible cooking devices needs to be supported with adequate power and behavioural interventions. Solar irrigation systems could support e-cooking more effectively if battery capacities align with multi-use demands or if cooking is scheduled during solar hours when generation is abundant (for those with power surplus to needs for irrigation and battery charging).

Finally, the study points to a broader policy implication: integrating gender analysis and household behaviour into energy access programs is essential for achieving equitable and sustained transitions to clean energy. EPCs, while promising, must be introduced within systems that recognize both physical constraints (battery size, solar availability) and social realities (decision-making authority, daily routines). With solar and battery costs continuing to fall, future pilots targeting different market segments—including less LPG-penetrated or lower-income regions—can refine these insights and identify where the coupling of solar irrigation and e-cooking yields the greatest development gains.

References

EED & VeraSol. (2021). *Quality in the off-grid solar market: An assessment of the consumer experience in Kenya.* https://verasol.org/publications/quality-in-the-off-grid-solar-market-an-assessment-of-the-consumer-experience-in-kenya/

Njagi, N. (2019, January 4). *Solar-pumped water slakes rural Kenya's thirst for development Thomson.* Reuters. https://www.reuters.com/article/us-kenya-solar-water/solar-pumped-water-slakes-rural-kenyas-thirst-for-development-idUSKCN1OY0DH/

Onsongo, E., Nayema, K., Kinuthia, B., Kausya, M., Okoko, A. (2023). *Kenya national baseline ecooking study (KNeCS) report.* Nuvoni Research. https://mecs.org.uk/publications/kenyan-national-baseline-ecooking-study-knecs-report/

Rahman, A., & Jain, A. (2021a). *Can Chhattisgarh further equity, prosperity, and sustainability through solar pumps?* Council on Energy, Environment and Water. https://www.ceew.in/publications/saur-sujala-yojana-for-sustainable-solar-pump-programme-in-chhattisgarh

Rahman, A., & Jain, A. (2021b). *How is India using its solar pumps for irrigation?* Council on Energy, Environment and Water. https://www.ceew.in/publications/solar-pumps-underutilization-and-usage-patterns-in-india

Wazed, S. M., Hughes, B. R., O'Connor, D., & Calautit, J. K. (2018). A review of sustainable solar irrigation systems for sub-Saharan Africa. *Renewable and Sustainable Energy Reviews, 81,* 1206–1225. https://doi.org/10.1016/j.rser.2017.08.039

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